METHOD AND APPARATUS FOR HUMAN INTERFACE WITH A COMPUTER

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part of copending U.S. Patent Application No. 09/876,031, filed on June 8, 2001, a copy of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a method and apparatus for the user of a computer to provide input to the computer. The method and apparatus replace or supplement inputs traditionally provided by a computer mouse.

BACKGROUND OF THE INVENTION

[0003] At the present time, human interface with most personal computers (PCs) is provided through the use of a keyboard and a mouse. A typical mouse is hardwired to the PC and requires that the computer user physically manipulate the mouse in order to input control signals to the PC. Movement of the mouse over the flat planar surface of a mouse pad may be used to move a cursor icon about the PC screen. Once the cursor icon is in a desired location on the PC screen, the user may "click" one or more of a plurality of buttons provided on the mouse to select an item at the screen location. Although a mouse is fairly simple to use, it requires a fairly sizeable clean flat surface for proper functioning. In some cases, mouse operation is hindered by the lack of a clean flat surface for a mouse pad in

the vicinity of the computer. Further complication may arise if the range of mouse motion over the mouse pad required for operation of the computer exceeds the range of motion of the user. Such a situation may occur, when, for example, the user is disabled or is a child. Accordingly, there is a need for an apparatus that can provide the functionality of a mouse (i.e. cursor movement and "clicking") without the need for a clean flat surface near the computer or the need for extensive motion by the user.

[0004] Keyboards are also typically hardwired to the PC and are designed to receive press down input from the computer user's fingers. Although keyboards may be used to rapidly input textual information, they require well developed user dexterity and understanding. Thus, the proper use of keyboards may be quite challenging for disabled persons or children. Accordingly, there is a need for an apparatus that can provide the functionality of a keyboard (i.e. input of textual information) without the need for highly developed user dexterity.

[0005] In the most basic sense, both a mouse and a keyboard provide the same functionality, they receive and transmit a user selection. User selection may be indicated by any change initiated by the user, such as pressing a keyboard key or clicking a mouse button. Accordingly, a candidate for replacement of either of these devices must also be able to receive and transmit a user selection by detecting a change initiated by the user.

[0006] Over the past decade, advances in computer based color recognition and hand gesture recognition have been used to provide substitutes for a computer mouse and keyboard. Color recognition may be used to signal a user selection by detecting the user's

change of a color displayed to a camera connected to the computer. Hand gesture recognition may be used to signal a user selection by detecting a change in the user's hand position as viewed by a camera connected to the computer. Examples of color recognition and hand gesture recognition systems, including some that use such recognition for control of a cursor on a screen, are provided in the following patents, each of which is incorporated by reference herein: (Color recognition: U.S. Patent Nos. 4,488,245; 4,590,469; 4,678,338; 4,797,738; 4,917,500; 4,954,972; 5,012,431; 5,027,195; 5,117,101; and 5,136,519) (Gesture recognition: U.S. Patent Nos. 4,988,981; 5,291,563; 5,423,554; 5,454,043; 5,594,469; 5,798,758; and 6,128,003). The gesture recognition systems that use only one camera are of most relevance to the various embodiments of the present invention, which also employ a single camera.

[0007] Although both color recognition and gesture recognition have been used generically to record user control signals, the systems employing these techniques have typically been complicated and/or finicky, requiring the use of a relatively high resolution camera for optimum results. The complexity of the systems has been necessitated by the need to make certain that true color and gesture changes are being recorded. A system that incorrectly detected color or gesture changes would not be suitable for control of a computer, as the user would be frustrated quickly by the registration of erroneous control signals. Accordingly, there is a need for a system that uses color recognition and/or gesture recognition and that accurately records user input, but is less complicated than known systems and can operate with a lower resolution camera, such as a commonly available web cam.

[0008] Applicant has determined that the foregoing needs may be met by a system that utilizes a combination of color recognition, gesture (i.e. hand shape) recognition, and/or hand motion recognition to reduce the likelihood of the registration of erroneous user input signals, while at the same time permitting the use of a lower resolution camera, such as a web cam. In at least some embodiments, the system and method of the present invention may provide significant advantages over the prior art. The use of color recognition, gesture recognition, and/or motion recognition in combination provides redundancy that may be used for improved user input detection, decreased camera resolution, or some combination of both. Additional advantages of embodiments of the invention are set forth, in part, in the description which follows and, in part, will be apparent to one of ordinary skill in the art from the description and/or from the practice of the invention.

SUMMARY OF THE INVENTION

[0009] In response to the foregoing challenges, Applicant has developed an innovative system for providing control signals to a computer, the system comprising a tube-like member adapted to reside on a finger of a computer user, the member having a distinct knuckle surface color and a distinct palm surface color, a camera operatively connected to the computer and adapted to view the member, and a means for converting a member surface color viewed by the camera into a control signal for the computer.

[0010] Applicant has also developed an innovative system for providing control signals to a computer, the system comprising a member adapted to reside on a finger of a hand of a computer user, the member having a distinct knuckle surface color and a distinct palm

surface color, a camera operatively connected to the computer and adapted to view the member, and means for converting a user hand position and a member surface color viewed by the camera into a control signal for the computer.

[0011] Applicant has also developed an innovative apparatus for providing control signals to a computer, the apparatus being adapted to reside on the finger of a computer user and comprising a knuckle surface having a first color, and a palm surface having a second color.

[0012] Applicant has developed an innovative system for providing control signals to a computer, the system comprising: a member adapted for hand-held use by a computer user; light emitting means disposed on the member, the light emitting means adapted to emit a first color responsive to a first member condition, and a second color responsive to a second member condition; a camera operatively connected to the computer and adapted to view the member and the light emitting means; and means for converting a color viewed by the camera into a control signal for the computer. The light emitting means may comprise a first LED adapted to emit the first color; a second LED adapted to emit the second color; and a battery selectively connected to the first LED and the second LED.

[0013] Applicant has also developed an innovative method of providing control signals to a computer using a camera and a tube-like member having three distinctly colored surfaces, the method comprising the steps of placing the tube-like member on one of a plurality of fingers on a hand of a computer user, placing the tube-like member and the hand in the camera field of view, selectively varying positions of the tube-like member and

at least one finger without the tube-like member, detecting a change in the color of the tube-like member colored surface in the camera field of view, detecting a change in the shape of the hand in the camera field of view, and generating a computer control signal responsive to the detection of a change in (a) the color of the tube-like member colored surface and (b) the shape of the hand.

[0014] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated herein by reference, and which constitute a part of this specification, illustrate certain embodiments of the invention and, together with the detailed description, serve to explain the principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In order to assist the understanding of this invention, reference will now be made to the appended drawings, in which like reference numerals refer to like elements. The drawings are exemplary only, and should not be construed as limiting the invention.

[0016] Fig. 1 is a pictorial view of a computer control signal input system arranged in accordance with a first embodiment of the present invention.

[0017] Fig. 2 is a pictorial view of a tube-like member that may be used with the system shown in Fig. 1.

[0018] Figs. 3 – 6 are pictorial views of various hand, finger, and tube-like member positions that may be assumed during practice of an embodiment of the invention.

[0019] Fig. 7 is a flow chart illustrating the steps of a method embodiment of the invention.

[0020] Fig. 8 is a pictorial view of a tube-like member formed by a cut-out finger puppet that may be used with the system shown in Fig. 1.

[0021] Fig. 9 is a pictorial view of a tube-like member in a first position according to an embodiment of the present invention that may be used with the system shown in Fig. 1.

[0022] Fig. 10 a pictorial view of a tube-like member in a second position according to an embodiment of the present invention that may be used with the system shown in Fig. 1.

[0023] Fig. 11 is a pictorial view of a wand-like member according to an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0024] With reference to Fig. 1, a computer control signal input system arranged in accordance with a first embodiment of the invention is shown. The input system includes a hollow tube-like member **200** mounted on the index finger **110** of the hand **100** of a user. The user hand **100** is located in front of a computer **300**. The computer **300** includes a monitor **310** having a viewable screen **312**, a camera **320** having a lens **322**, and a hardware device **330** having a processor, memory and other commonly known components of a PC. The monitor **310** and the camera **320** are operatively connected to the hardware device **330** by cables.

[0025] With reference to Fig. 2, the tube-like member **200** may include a knuckle side

surface **210**, and palm side surface **220**, and a tip surface **230**. In the preferred embodiment of the present invention, each of the knuckle, palm and tip surfaces are provided with a different and distinct color. The tube-like member **200** may be hollow and have an opening **202** at one end adapted to receive a finger of the user. Preferably, the tube-like member **200** is fitted to stay securely on the user's finger without rotating, while at the same time being comfortable to the user. When inserted on the user's finger properly, the knuckle side surface **210** of the member **200** should be substantially aligned with the knuckle side of the user's hand and the palm side surface **220** of the member should be substantially aligned with the palm side of the user's hand.

[0026] In alternative embodiments of the invention, the tube-like member **200** may be provided with only two distinct colors located on the knuckle side and the palm side of the member, respectively. The tip color of a tube-like member **200** with only two distinct colors may be provided by the color of the user's fingertip. In still other alternative embodiments, an example of which is shown in Fig. 8, the tube-like member **200** may be provided in the form of a finger puppet, having human or animal like features. The finger puppet may be cut out from paper or cardboard stock and glued, stapled, taped, or otherwise fashioned together to form a tube-like structure.

[0027] Another embodiment of the present invention is shown in Figs. 9 and 10, in which like reference characters refer to like elements. A first LED **240** and a second LED **250** are disposed on the member **200**, and each is adapted to emit a different and distinct color from the other. In one embodiment, the first LED **240** may be disposed on the tip

surface **230** of the member **200** and the second LED **250** may be disposed on the knuckle surface **210** of the member **200**. In other embodiments, the first and second LEDs may be positioned on any one or more of the surfaces of the member **200**. The first LED **240** and the second LED **250** may be used in conjunction with a member **200** having distinctly colored knuckle, palm, and tip surfaces, as described above. In this manner, the first LED **240** and the second LED **260** may supplement the color recognition aspects of the input system. Alternatively, the first LED **240** and the second LED **260** may provide sufficient color distinction that distinctly colored knuckle, palm, and tip surfaces on the member **200** are not required.

[0028] A conventional power source **260**, such as, for example, a battery, may be disposed on the member **200**. The battery **260** includes a positive contact **262** operatively connected to the first LED **240** and the second LED **260**, and a negative contact **264**. The negative contact **264** of the battery **260** selectively connects with the negative contact **244** of the first LED **240** or the negative contact **254** of the second LED **250** to complete an electrical circuit and supply power to the respective LED.

[0029] Fig. 9 shows the member **200** in a pointed finger position. In this position, the negative contact **264** of the battery **260** connects with the negative contact **244** of the first LED **240** and supplies power to the first LED **240**. Accordingly, the first LED **240** emits a light having a first color. In this position, the electrical circuit between the battery **260** and the second LED **250**is not completed, and the second LED **250** is "off." When the user wishes to provide a different input to the computer, the user may bend their finger to a

closed position, as shown in Fig. 10. In this position, the negative contact **264** of the battery **260** disengages with the negative contact **244** of the first LED **240**, and connects with the negative contact **254** of the second LED **250**. The second LED **250** emits a light having a second color. It is contemplated that the first LED **240** and the second LED **250** may be replaced with a single, bi-color LED without departing from the scope and spirit of the present invention.

[0030] Another embodiment of the present invention is shown in Fig. 11, in which like reference characters refer to like elements. The member **200** comprises a wand-like member adapted for hand-held use by the computer user. The member **200** includes a first LED **240** and a second LED **250** disposed in the tip of the member **200**. A conventional power source **260**, such as, for example, a battery, is provided in the member **200**. The battery **260** includes a positive contact operatively connected to the first LED **240** and the second LED **260**, and a negative contact. As will be apparent to those of ordinary skill in the art, a user may operate a switch **270** to selectively connect the negative contact of the battery **260** with the negative contact **244** of the first LED **240** or the negative contact **254** of the second LED **250** to complete an electrical circuit and supply power to the respective LED.

[0031] The camera **320** may be any commonly available camera for use with a PC, such as a web cam. The camera **320** is shown in a position atop of the monitor **310**, however, it is appreciated that the camera could be located in other places in the general vicinity of the monitor. The horizontal polarity on the lens **322** of the camera may be

reversed so that it also acts as a mirror for the user. The mirrored surface of the lens **322** may allow the user to see her hand positions as they are viewed by the camera **320**.

[0032] The hardware device **330** may include one or more programs stored in memory that convert color changes and/or hand gesture changes viewed by the camera **320** into control signals.

[0033] The input system may be operated as follows to provide control signals to the computer **300**. With reference to Fig. 1, in a first step, the tube-like member **200** may be placed on one of a plurality of fingers **110** on the hand **100** of the computer user. The tube-like member **200** is aligned such that the knuckle side **210** of the member is on the knuckle side of the user's hand, and the palm side **220** of the member is on the palm side of the user's hand. Next, the user's hand **100**, including the tube-like member **200** is placed in the field of view of the camera **320**. The hand **100** may be in any of the positions shown in Figs. 3-6 to initiate the process. It is assumed in this embodiment that the initiation position will be that shown in Fig. 4. The color recognition aspect of the computer program stored in the hardware device **330** may be used to locate the tube-like member **200**, which should have a distinctive color. The location of the tube-like member **200** in the camera **320** field of view enables the system to locate and focus in on the general location of the hand **100** as well, because the hand is naturally near the tube-like member. In this manner, the color recognition aspect of this embodiment of the invention supplements the gesture recognition aspect by enabling the system to locate the hand for gesture recognition.

[0034] Pursuant to the steps illustrated in Fig. 7, the hardware device **330** uses the camera **320** to recognize the shape of the hand. Shape recognition (which may utilize recognition of the hand color as well) is used to distinguish between the open hand position (shown if Fig. 4), the pointing position (Fig. 3), and the closed hand position (Fig. 5). Movement of the hand **100** may also be detected to assist in distinguishing the hand from a flesh colored background, such a the user's face.

[0035] Thereafter, the position of the hand **100** and the tube-like member **200** may be selectively varied to any of the positions shown in Figs. 3-6, as well as others. The camera sends the visual information regarding the hand **100** and the tube-like member **200** to the hardware device **330**. Differences in the color of the displayed surface of the tube-like member **200** (including the color emitted from the first LED **240** or the second LED **250**, if provided) and the shape of the hand **100** are detected by the hardware device **330** and used for the generation of a computer control signal. The hardware device **330** detection of a change in the shape of the hand (gesture change) may be used to supplement the color change information for the computer control signal generation. In the preferred embodiment of the invention, the generation of the computer control signals is responsive to the detection of a combination of change in (a) the color of the tube-like member colored surface (including the color emitted from the first LED **240** or the second LED **250**, if provided); and (b) the shape of the hand.

[0036] Various hand **100** and tube-like member **200** positions may be used to signal various computer commands, such as cursor movement, clicking, double clicking, scrolling,

etc. For example, in a preferred embodiment of the present invention, the hand **100** and tube-like member **200** position shown in Fig. 6 (with the tube pointed at the camera so that the tube tip color is viewed) may be used to control cursor movement over the monitor screen **312**. By communicating with the computer's operating system the cursor is controlled by hand positions and motion. The hand **100** and tube-like member **200** position shown in Fig. 5 may be used to signal a "click." When the hand and tube are in the position shown in Fig. 6, slight changes in the pointing direction of the index finger may be used to move the cursor about the monitor screen, to write on-screen, or to "finger" paint on-screen. The use of software such as Graffiti™ used in Palm OS™ may allow the user to convert hand writing into typed text.

[0037] Unlike other gesture recognition applications, in a preferred embodiment of the present invention, control signals are computed in response to the pointing finger's exposed colors, the luminance level of the tip and whether or not it is accompanied by neighboring fingers when in a pointing position. The system will not rely on differential keying, glob recognition, electronic sensors, or more than one camera. In addition, when pointed the top of the finger tube provides a precise reference point to use for drawing, painting and writing applications with accuracy well beyond that of a computer mouse or gesture recognition systems used for virtual reality games.

[0038] It is to be understood that the description and drawings represent the presently preferred embodiment of the invention and are, as such, a representative of the subject matter which is broadly contemplated by the present invention. It is further understood that

the scope of the present invention fully encompasses other embodiments that may become obvious to those skilled in the art, and that the scope of the present invention is accordingly limited by nothing other than the appended claims.